

# **Apraxia: An Action To Understand Inaction**

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# Objectives

- ❑ Define Apraxia and the areas of the brain affected.
- ❑ Recognize the motor planning issues.
- ❑ Evaluate the current treatment and gaps.
- ❑ Outline and understand the role of Anterior Midcingulate Cortex (aMCC)
- ❑ Novel therapy aimed at neuro recovery for motor planning.

# Apraxia

- ❑ Frequent consequence following brain damage.
- ❑ Covers a spectrum of disorders.
- ❑ PRAXIS is a suffix, which means to achieve OR to do OR to perform...

Hence ....



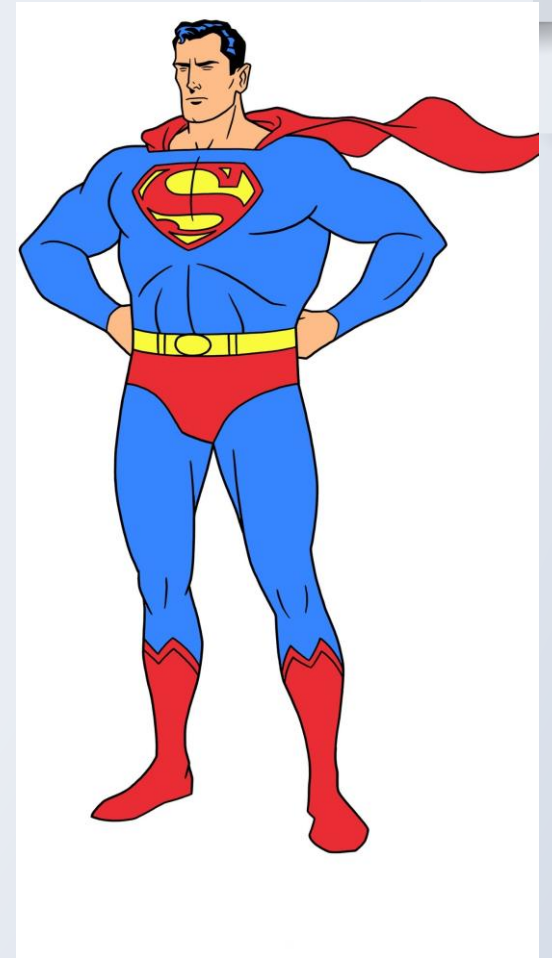
# Apraxia: Definition

- ❑ Affects purposeful execution of learned and meaningful skills that cannot be explained by primary sensory or motor impairments and nor by deficits in motivation, memory or comprehension.
- ❑ Deficits in performing, imitating and recognizing skilled actions required for intentional movement.

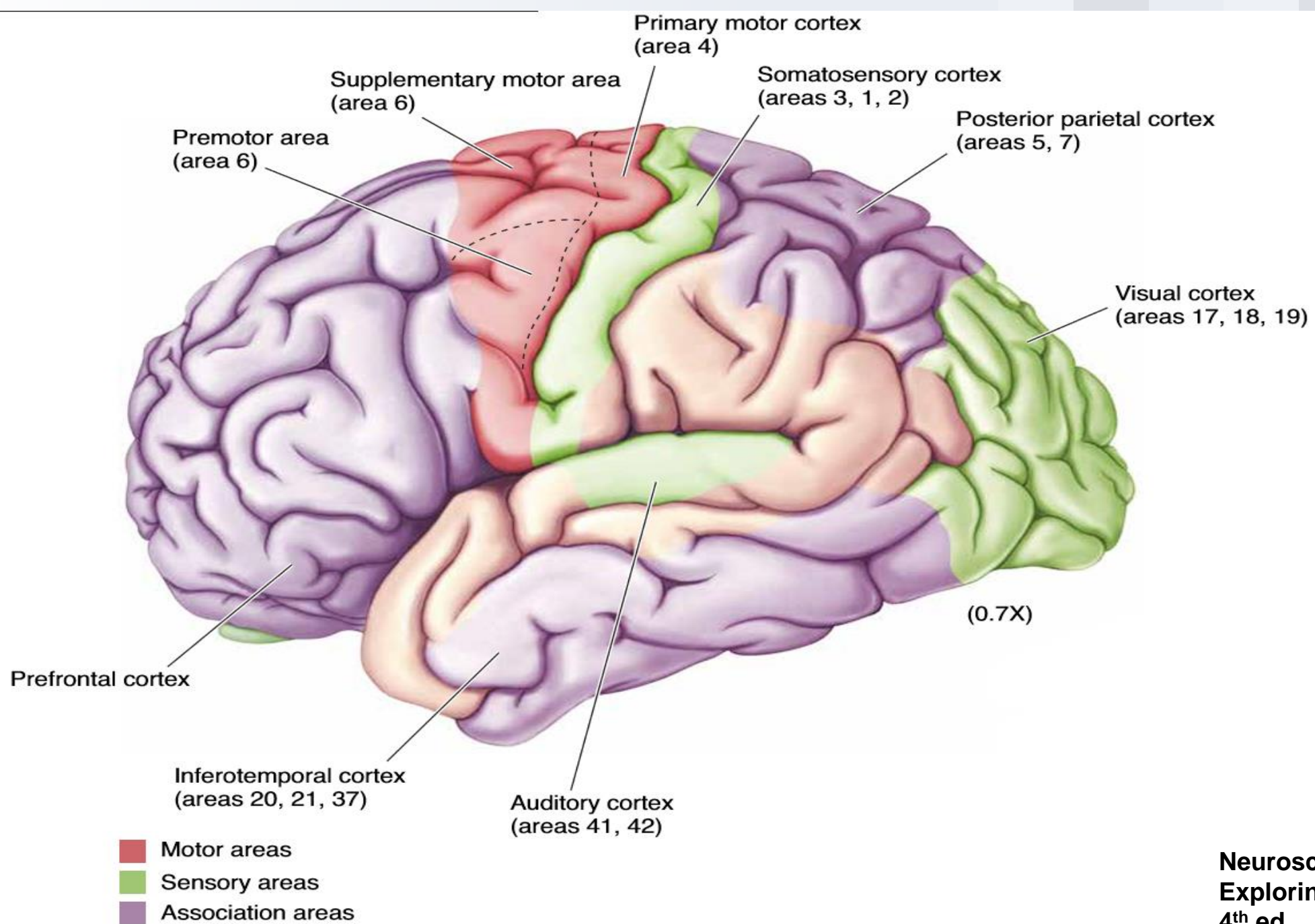


# Apraxia: Definition

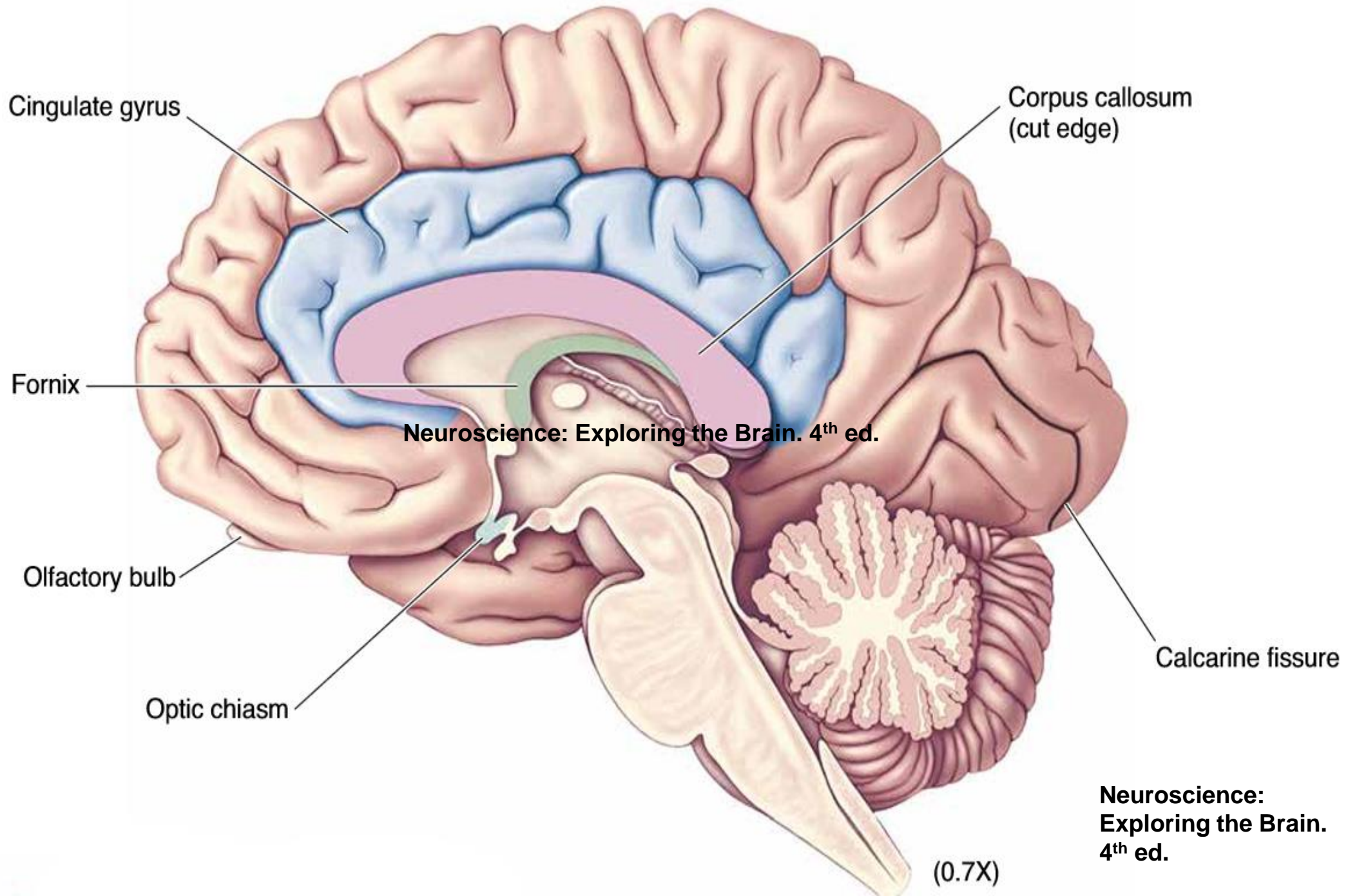
- ❑ Inability to evince the concept of specific actions or execute motor programs.
- ❑ Inability to execute gestures in response to verbal commands.
- ❑ Most commonly occurs after Left hemisphere damage: organization of motor control.











Cingulate gyrus

Corpus callosum  
(cut edge)

Fornix

Neuroscience: Exploring the Brain. 4<sup>th</sup> ed.

Olfactory bulb

Optic chiasm

Calcarine fissure

Neuroscience:  
Exploring the Brain.  
4<sup>th</sup> ed.

(0.7X)

# Classification of Apraxia

- ❑ Ideational: problem affecting the concept of task performance, action plan that is needed to perform the task is absent/ disrupted.
- ❑ Ideomotor: Internal concept of task performance is intact, conversion of plan to action is disturbed.
- ❑ Action disorganization syndrome: Inability to carry out multi step actions; arises from a double deficit. Caused by damage to the stored knowledge of routine action schemas.

# Impact Of Apraxia

- ❑ Affects skilled action in the environment.
- ❑ Interferes with independence.
- ❑ Performance of ADL's.
- ❑ Reduced Quality of Life.
- ❑ Challenges in prognosis: transfer to home, dependent living.

# Clinical Diagnosis

- ❑ May largely rely on clinical judgement.
- ❑ ADL observation; *Arnadottir*. Task selected by patient.  
Good inter-rater reliability, internal consistency, clinical and construct validity
- ❑ Apraxia Test: 2 subsets, one for ideational: evaluate the use of an object

# Other Cognitive Screening Tests

- ❑ Dutch Letter Cancellation Test
- ❑ Reven's Colored Progressive Matrices
- ❑ Rivermead Behavioral Memory Test
- ❑ Trial Making Test
- ❑ Tower of London Test
- ❑ Token Test

# Correlation and Reliability

- ❑ ADL observation has good inter-rater reliability
- ❑ Apraxia test: Above 60%; good interrater reliability.
- ❑ Association with other Cognitive Impairments: Significant correlations between Apraxia and scores on Token Test, Letter Cancellation Test, Rivermead Behavioral Memory Test, Tower of London, Trial Making Test Part A.
- ❑ Apraxia correlated with Aphasia, memory and mental speed.

Pazzaglia M, Guilia G.

Zwinkels A, Geusgens P, Van De Sande C



# Limitations

- ❑ Limited sample size.
- ❑ Did not assess based on different tests.
- ❑ Another study found poor relationships between several Apraxia test.
- ❑ **Suggest that functional and behavioral indices in ADL tasks should be considered more clinically relevant than pure test scores.**

# Treatment Approaches

- **Compensatory Strategy Training.**
- **Action Observation.**
- **Motor Selection Priming.**

# Phases of Task Performance

## Orientation

- Sensory information about task, aware of environment, objects present, and the task to be performed.
- Interpret the information, construct an internal concept of the task.
- Internal concept: action plan, describe organization and planning of env., objects and motor programs, image of task.

## Execution

- Action plan is carried out, motor activities to be started, continued and finished.
- Action should be smooth, and timing should be appropriate.
- Anticipatory behavior is expected to control problems.

## Control

- Focus on the results, process and final result should be registered and compared to the internal concept, judged and corrected if necessary

# Compensatory Strategy Training

- Teach strategies to compensate for Apraxia.
- Aims at improving ADL performance.
- Little change in Apraxia is expected.
- Requires awareness of their deficit to be present.
- Greater success when the selected tasks are meaningful to the patient.
- Train in the natural environment.

# Compensatory Strategy Training

- ❑ Selection of task.
- ❑ Based on ADL observation.
- ❑ One phase will be addressed during training.

# Compensatory Strategy Training: Training Techniques Used

- ❑ Verbalization.
- ❑ Written action plan.
- ❑ Pictures showing objects needed for task performance.
- ❑ Pictures showing the correct sequence of task performance.
- ❑ Video showing the patients own performance.

**Follows instruction pattern: wait, provide verbal cues, then physical assistance, then assistance through the entire task if needed.**



# Compensatory Strategy Training

## Pros

- ❑ Significant improvement in ADL performance after a 12-week intervention.
- ❑ Some transfer of training from trained to untrained tasks noted.

## Cons

- ❑ No specific long-term improvements noted when compared to traditional rehabilitation.
- ❑ Does not aim at re-learning the task.

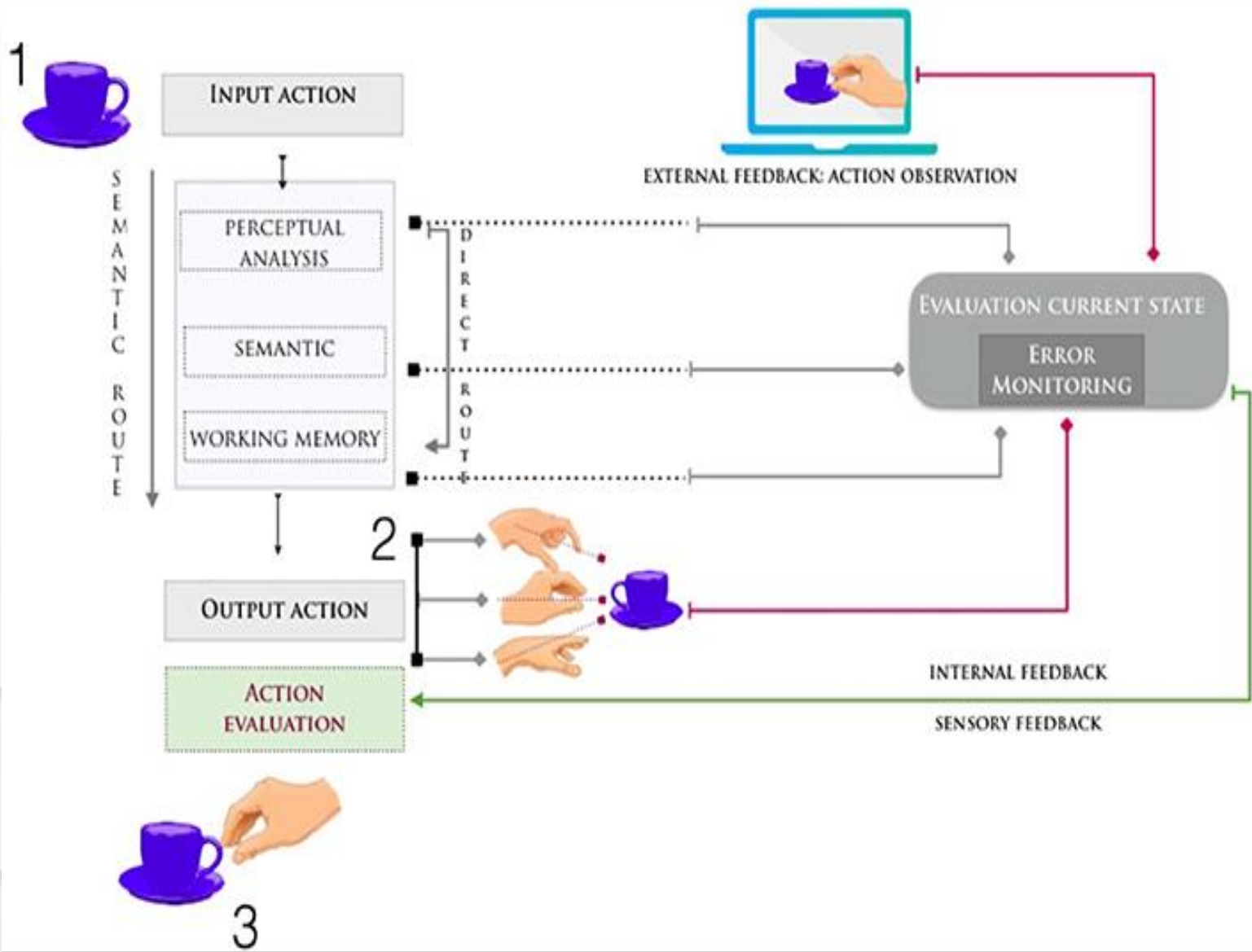
# Action Observation And Execution

- ❑ Movement execution is not purely a motor process.
- ❑ Visual representation of the given action/ movement affects execution.
- ❑ Perception and motor control are closely related.
- ❑ Noted improvements in patients with fronto-parietal lesions.

Pazzaglia M, Galli G

# Action Observation And Execution

- Mirror Neuron System: Action Observation Network consisting of the parietal, frontal and superior temporal sulcus.



1. Visual processing of the object
2. Retrieval of the most probable actions associated with the object
3. Selection of correct action after the observation of a video clip or a real demonstration of correct action.

# Action Observation And Execution: Training Techniques Used

- ❑ Demonstrate gesture execution and ask the patient to imitate.
- ❑ Reduce support as improvements noted.
- ❑ Provide the functional meaning of object details for various actions.

# Action Observation And Execution

## Pros

- ❑ May drive re-learning and plastic changes.

## Cons

- ❑ Minimal effects from trained to un-trained tasks.
- ❑ Performing same tasks at home was crucial.



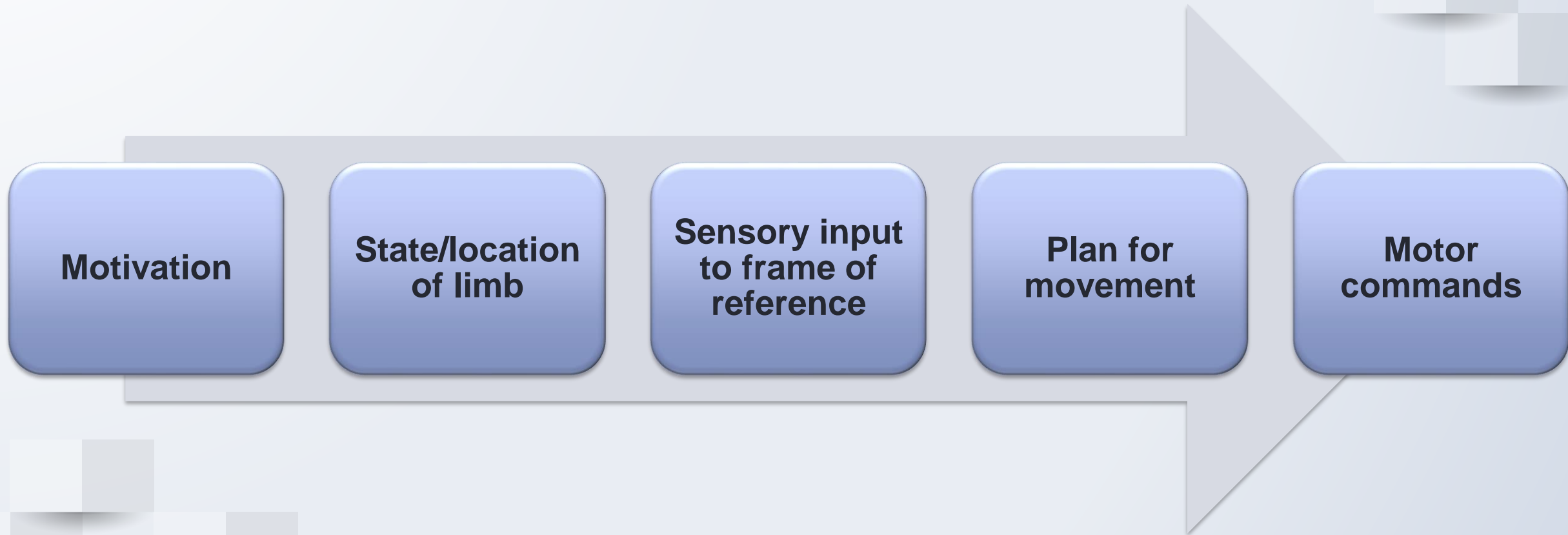
# Limitations

- ❑ Both techniques require the awareness of deficit to be present to some extent.
- ❑ If not present, may reduce the success of intervention.
- ❑ They address challenges in movement that are visible but not the processes that occur before that.

# **Motor Selection Priming**

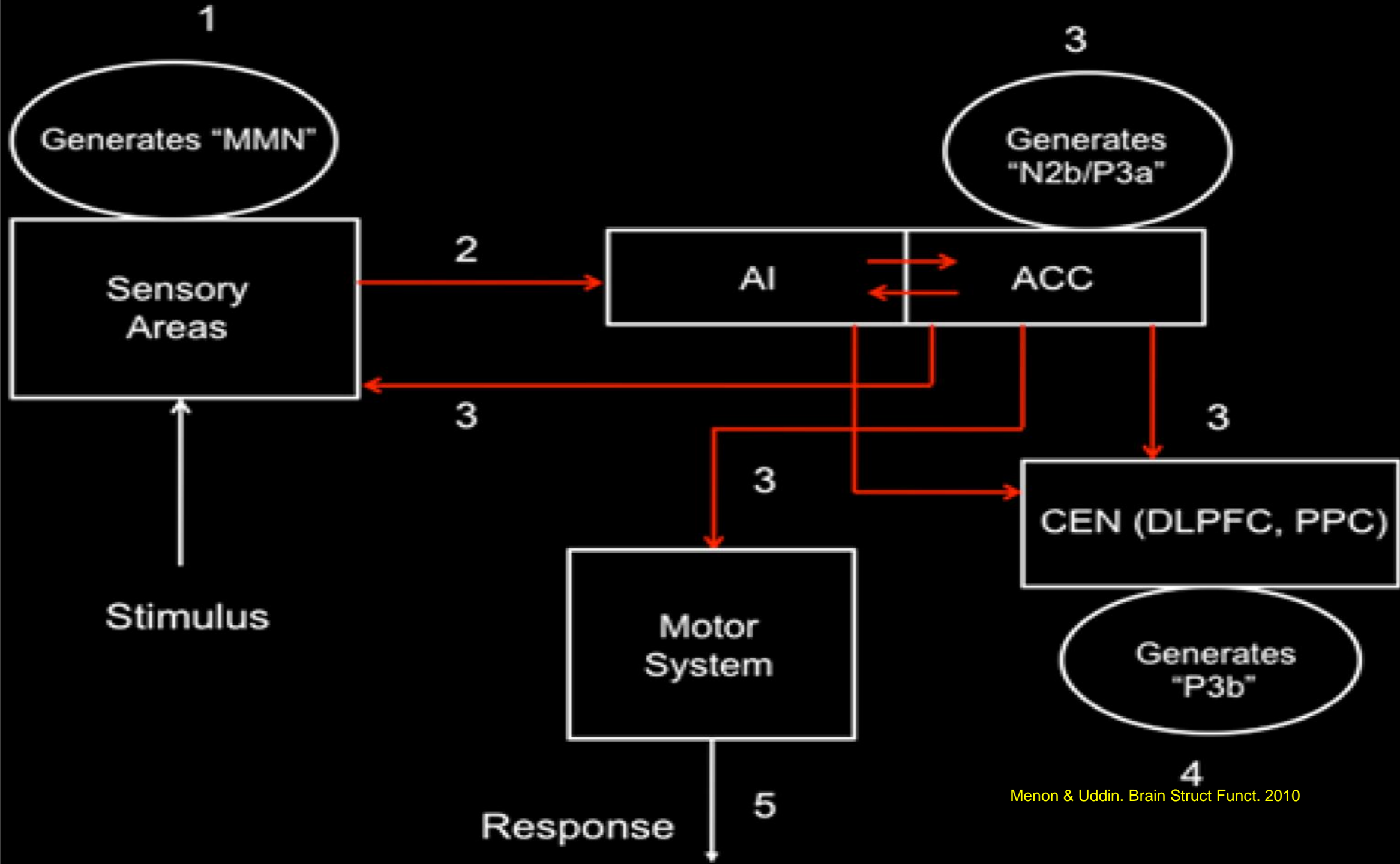
# Motor Plan

- ❑ Dominant versus sub-dominant.
- ❑ Cognitive motor control.
  - ❑ Intention to move, non-reflexive.



# Before we know

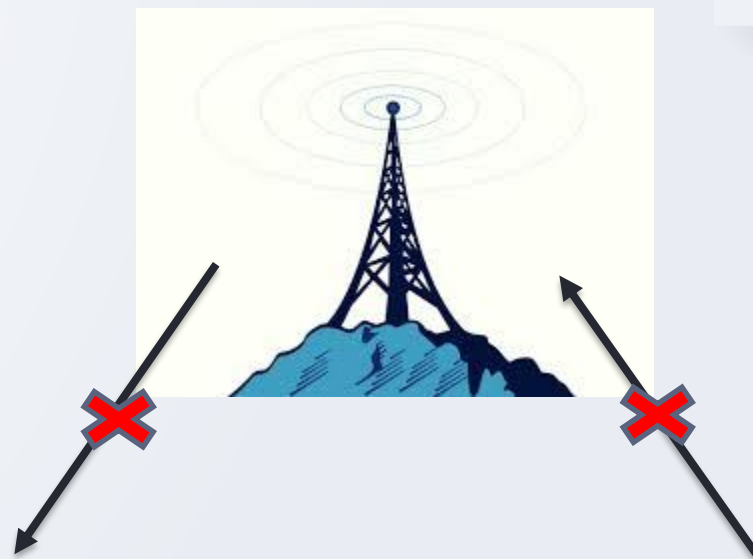
- ❑ Bereitschaftspotential.
  - ❑ One or multiple plans are already happening before we know it.
    - ❑ Simultaneous representations.
    - ❑ Funneled to one choice.
  - ❑ What does this mean?
    - ❑ Even though we have the intent to move it doesn't mean we know what it will be yet.
    - ❑ How does this apply to apraxia?





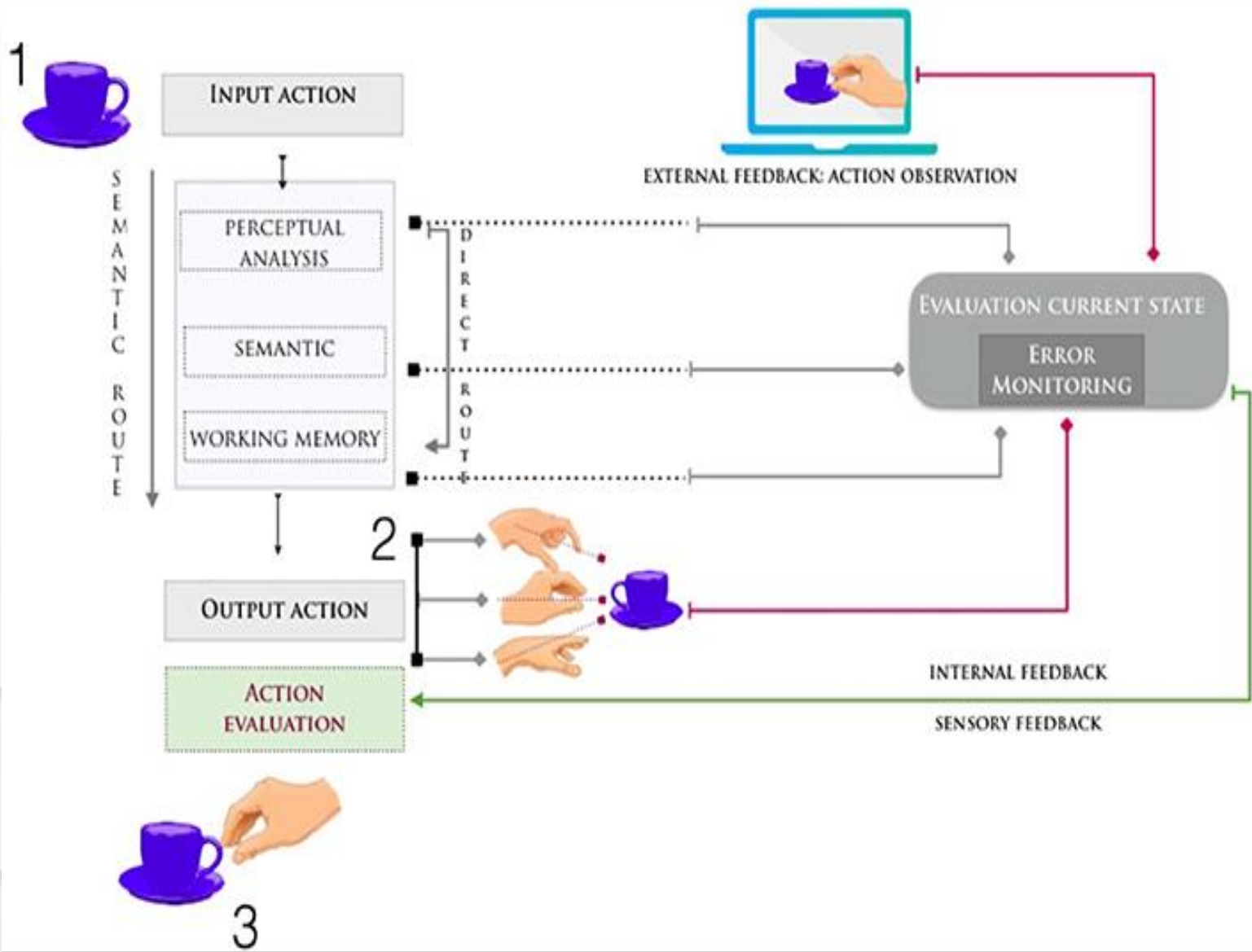
# Pathways

- ❑ Functional Networks
  - ❑ Not working in isolation.
  - ❑ Corresponding areas “light up” with use of one in network.
- ❑ Disruption is similar to cell phone service.



# Anterior Cingulate Cortex (ACC)

- Role in intentional motor control
  - “Abstract cognition and intention to action, connecting cognitive and motor systems” - Hoffstaedter F, et al.
- Conflict monitoring and adaptive response



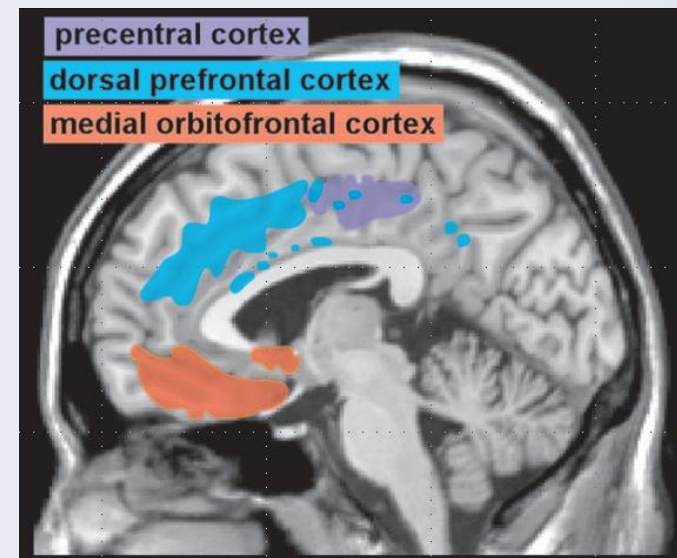
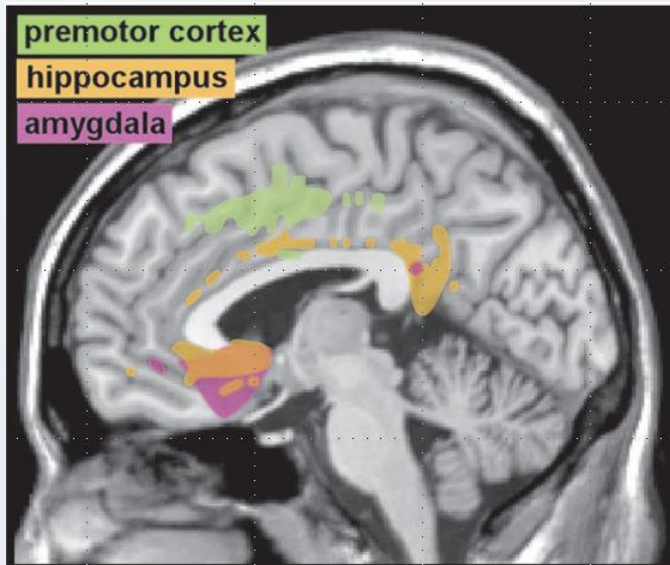
1. Visual processing of the object
2. Retrieval of the most probable actions associated with the object
3. Selection of correct action after the observation of a video clip or a real demonstration of correct action.

# Anterior Cingulate Cortex (ACC)

- ❑ Selection and execution.
- ❑ Tumors here-“loss of spontaneity in emotion, thought, and activity” -Allman JM, Hakeem
- ❑ Rich dopaminergic input.

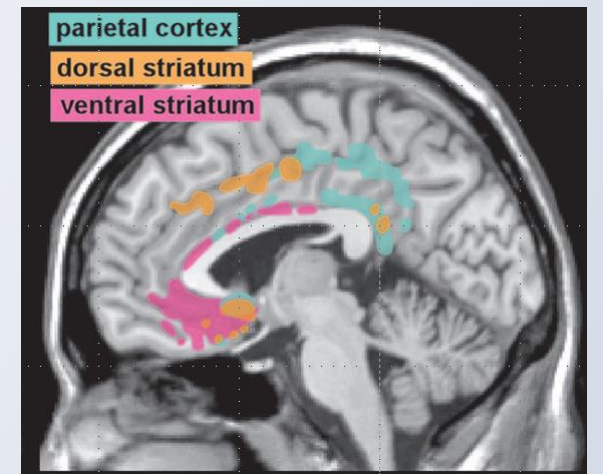
# Functional Connectivity of ACC

- ❑ Premotor and Motor areas.
- ❑ DLPFC-cognitive area of brain involved in motivation, execution.
  - ❑ Cognition/attention and action inhibition.



# Functional Connectivity of ACC

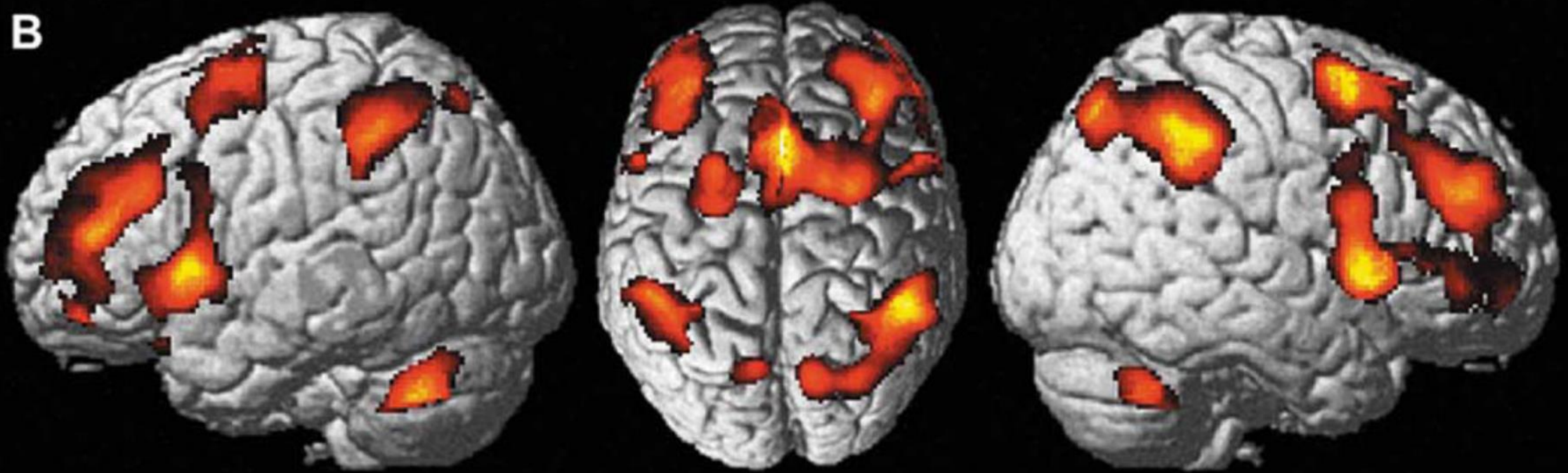
- ❑ Dorsal striatum in basal ganglia.
  - ❑ Self initiated movement.
- ❑ Parietal cortex-implicated in apraxia.
  - ❑ Roles with sensory information to motor plan.
- ❑ Anterior insula.
  - ❑ Importance of information.





# Neural Correlates of Intentional Movement Generation

B



**Let's do a little exercise**

Green

Red

Blue

Yellow

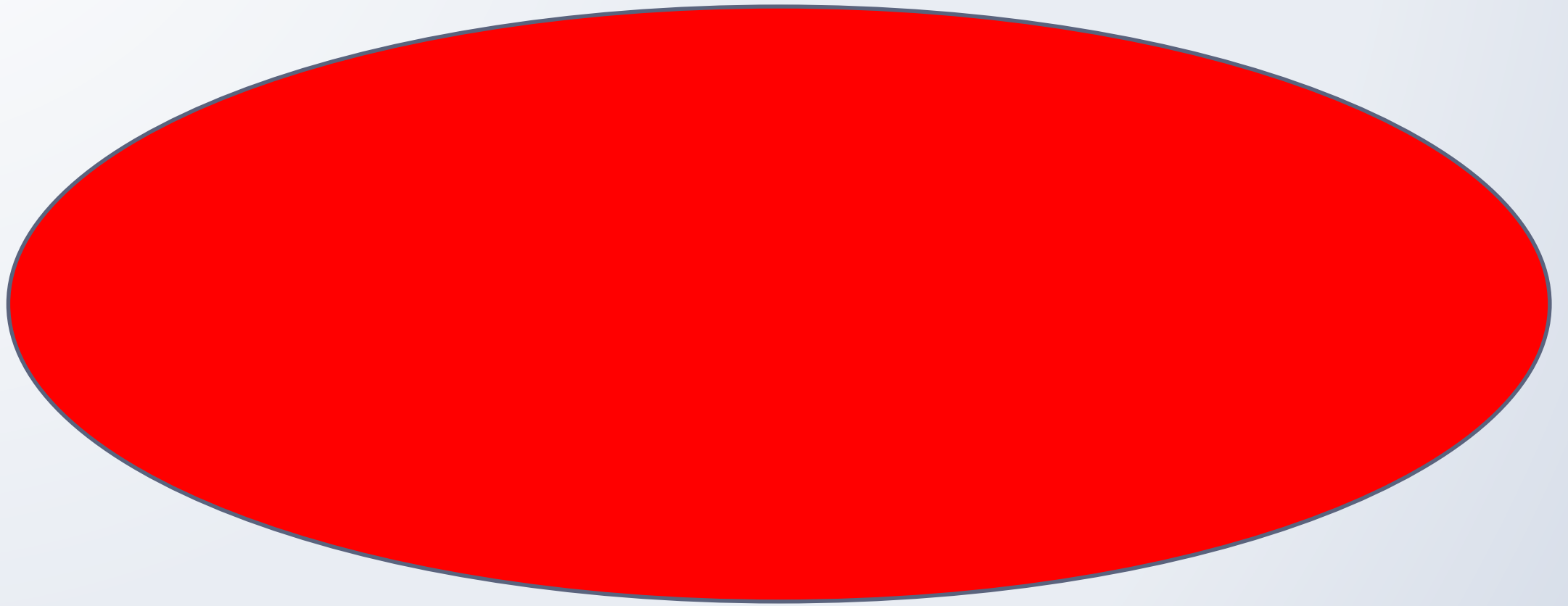
Orange

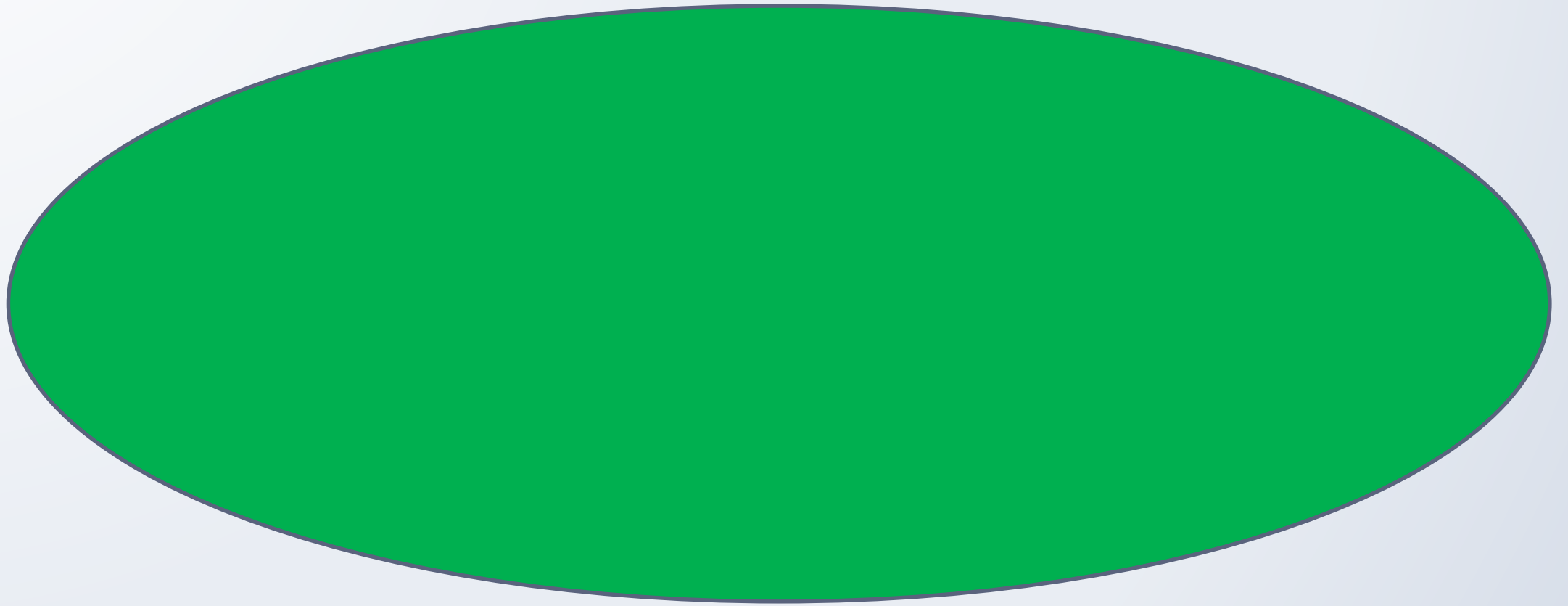


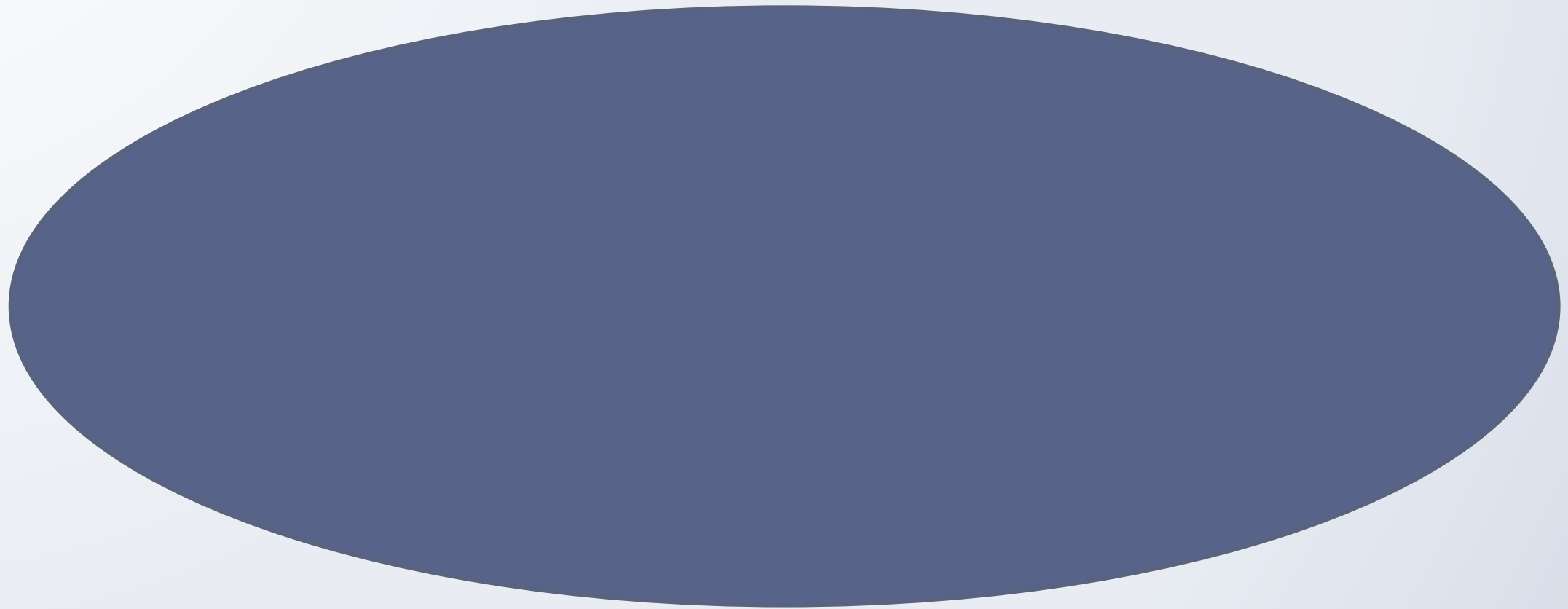
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**Ok.**

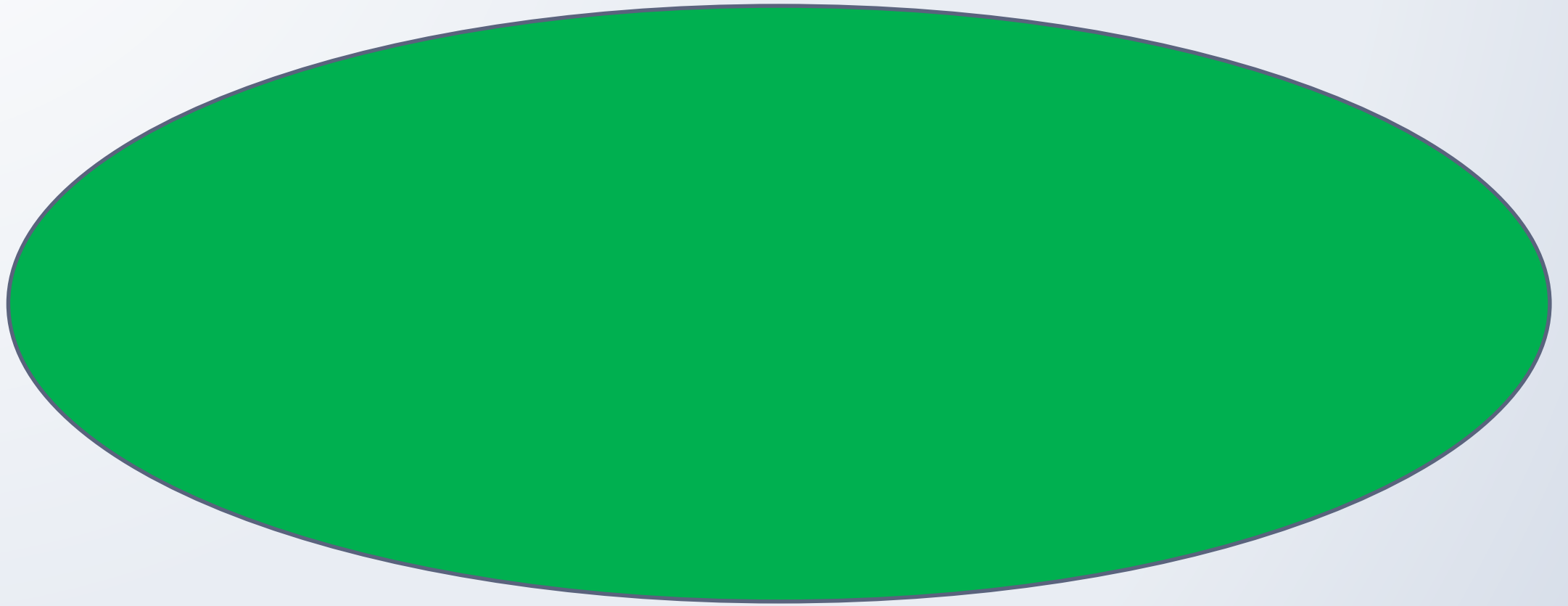
**Now let's do another one..!**







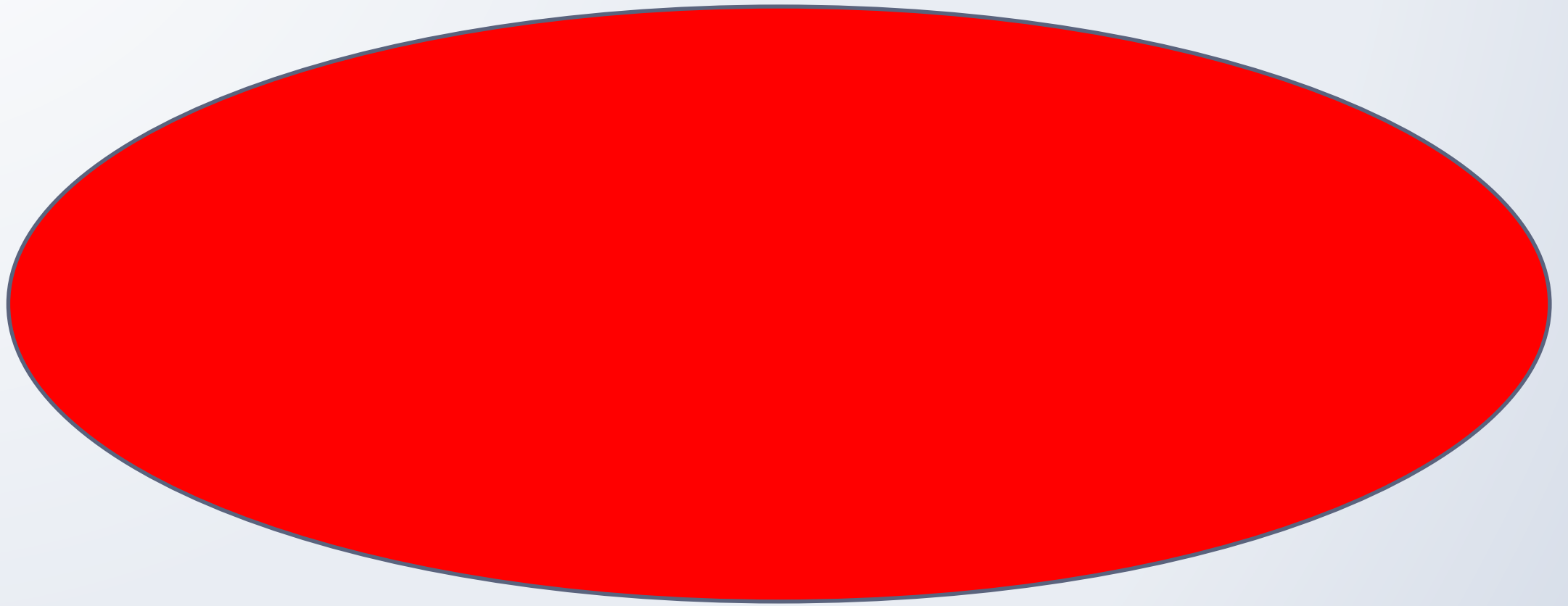












# What were those?!

- Stroop

- Conflict detection and monitoring of motor execution.
- Natural or dominant tendency must be suppressed.
- Forcing more of your intention and more cognitive action.

- Go NoGo

- Action Inhibition- you have a plan ready and you must stop it.

## Variations

▣ 1111

▣ 444

▣ 88888

▣ 2 7

▣ 3 4

▣ 8 0

# Pros

- ❑ Takes only minutes to implement.
  - ❑ Can add into other established programs.
- ❑ Can be done between sets.
- ❑ No big set up, Easy access.
- ❑ Aim is to induce neuroplastic changes.

# Cons

- ❑ Stroop may require unaffected speech.
- ❑ Visual deficits may effect performance.
- ❑ Can induce frustration.

# Case Study 1

- ❑ Mid-aged M, injured primarily on R side, L sided deficits to UE, LE, L homonymous hemianopsia, L spatial field deficits.
- ❑ Did not demonstrate movement apraxia but more action disorganization syndrome.
- ❑ Decreased quality of performance on subdominant tasks or those involving multiple steps.
  - ❑ Stepping patterns onto aerobic step
  - ❑ Omission errors with sub goals



# Implementation

- ❑ Used color and numeric Stroop Test on handheld balls and tablets.
- ❑ Go NoGo on tablet.
- ❑ Performed as warm-ups or between dominant to sub-dominant tasks or multi-step tasks.

# Improvements

- ❑ Increase in quality of performance in sub-dominant tasks.
- ❑ Increase knowledge of performance versus that of results.
- ❑ Insight into intermediate steps/sub-goals of multi-step movements.

# Case Study 2

- ❑ Young Adult with a Traumatic Brain Injury: Encephalomalacia of R temporal, parietal and occipital lobe with extra vacu dilation of post horn of R lateral ventricle.
- ❑ Difficulty in performing ADL's, initiating tasks in a timely manner.
- ❑ Able to communicate the steps involved in the task, however unable to perform them on verbal cueing.

# Implementation

- ❑ Used color and numeric Stroop Test on handheld balls and tablets.
- ❑ Go NoGo on tablet.
- ❑ Used 'Llama Duck' game: to mimic Go NoGO task.
- ❑ Performed as warm-ups or between dominant to sub-dominant tasks or multi-step tasks.



# Improvements

- ❑ Increase in quality of performance in sub-dominant tasks.
- ❑ Improvement in dominant task on observation.
- ❑ Possible improvement noted in attention and awareness during therapy session.

# Where do we go next?

- ❑ Developing a more comprehensive framework for understanding motor planning.
- ❑ Supported by further research, using the functional connectivity network to support clinical investigation and creation of protocols.

**Questions?**



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